Space Weather Technical Forecast

Issued on Monday, 28 March 2022 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares throughout. Slight chance of proton storms. Slight chance of Active fluence by Days 3 & 4 (30-31 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate in the past 24 hours, with one M-class flare (M4) originating from AR2975, at 28/1128 UTC. Awaiting coronagraph imagery to see if it produces a CME. There are currently six numbered sunspots on the visible disc. AR2975 has developed significantly in the past 12 hours, and is showing a magnetically complex setup, with two delta spots evident within the region, although no significant flares as yet. AR2978 is currently difficult to classify due to its proximity to the southeast limb, although a trailing sunspot is emerging from around the limb. This will be further analysed as it continues to rotate onto the visible disc. AR2976 in the northeast quadrant is the largest of the sunspot groups, although currently appears to be stable. AR2977 to the northwest of AR2975 has continued to show some slow development through the last 12 hours. AR2979 in the southeast quadrant has shown some development, with growth in its intermediate spots. The much smaller spot AR2974 (which produced an M1 flare on 25th) is now small, simple and inactive. No Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR at L1 are indicative of a high speed stream, likely from CH69/+. Wind speeds have been mostly elevated, ranging from 480 to 560km/s. The density has been mostly above average, with a peak of 13 ppcc at 27/1800 UTC. The strength of the IMF, Bt, has been at weak to moderate levels, peaking at 11nT at 27/1615 UTC. The north-south component, Bz, varied between +8 and -9 nT. The Phi angle was predominately positive (away from the Sun), but with brief transitions to negative. Geomagnetic activity was Quiet to Active (Kp 2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2MeV) has also been at Background levels. The 24-hour integrated electron fluence was well below the Active (1e8 integrated pfu) threshold on a declining trend, with the observed fluence at 28/0000 UTC 1.05e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, with further C-class flares expected. There is a chance of activity increasing to Moderate levels, with isolated M-class flares. The recent rapid and complex development of AR2975 and a better view of AR2978 when it's more fully on the disc may cause these probabilities to be revised again.

Solar Wind / Geomagnetic Activity: Solar wind speeds are currently elevated, due to the high speed stream from CH69/+. They are expected to remain elevated through Day 1 (28 Mar), slowly easing through Day 2 (29 Mar) as the coronal hole effects wane. Solar winds should be a background levels Days 3 and 4 (30-31 Mar).

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Quiet to Unsettled (Kp 1-3) conditions are expected Day 1, with a chance of isolated Active (Kp 4) intervals. Geomagnetic activity is expected to become predominantly Quiet during Day 2 and continue through to Day 4 (31 Mar).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be mostly at Background levels. However, there is a slightly raised risk of a radiation storm due to the recent significant development of AR2975 and its position on the sun, making any potential large flare Earth-directed.

The high energy electron flux is currently at Background levels. As the current HSS wanes, then a rising trend in electron flux values is possible through the coming days, perhaps reaching High levels at the diurnal peaks by Days 3 and 4 (30-31 Mar). This is low confidence however. The associated 24 hour fluence may follow an erratic rising trend through the next four days, although levels are likely to remain below the Active (1e8 integrated pfu) threshold.

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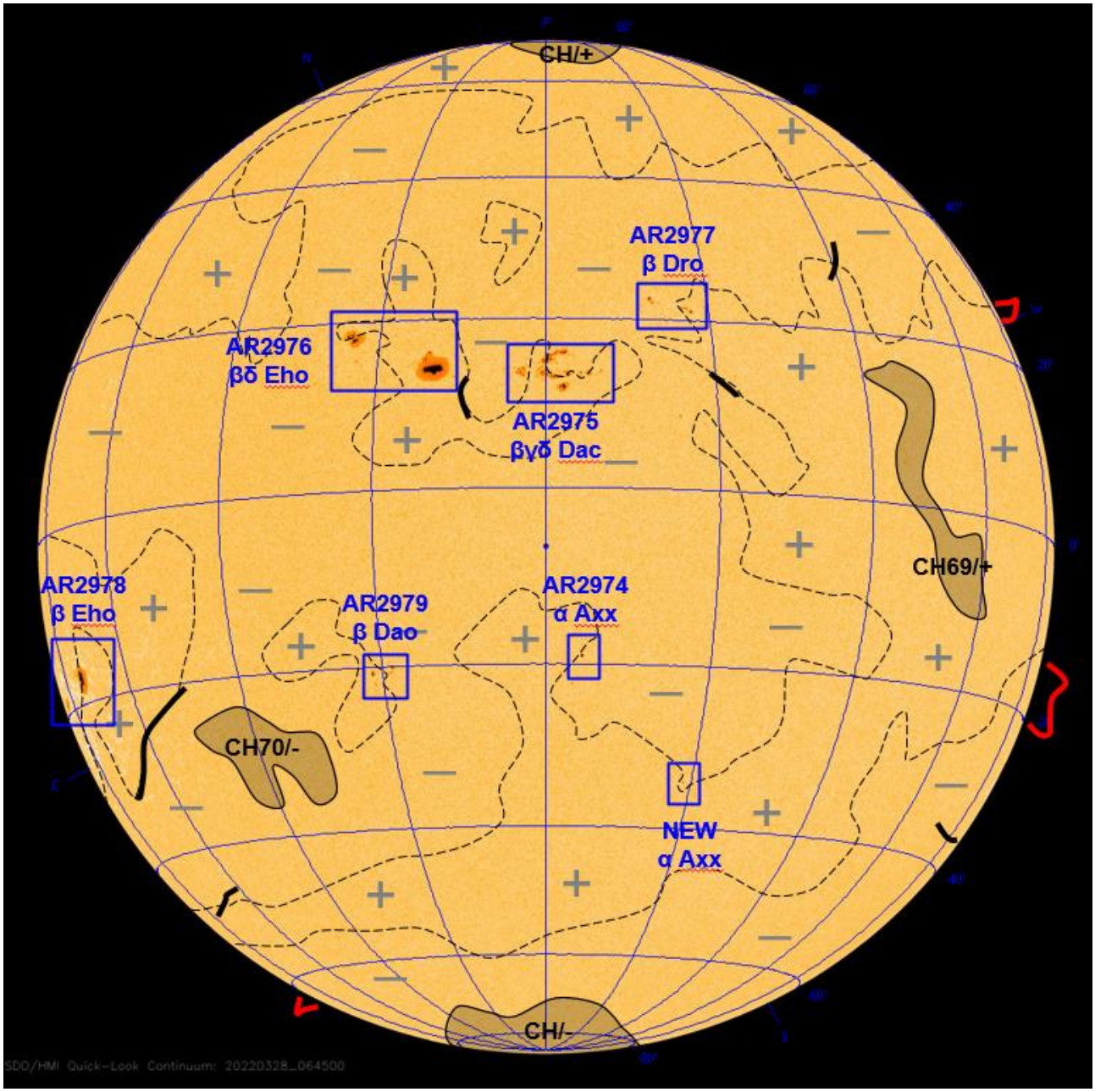
Figure 1. Solar Analysis Valid 28/0645 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME which left the sun on the 25th arrived at STEREO-A overnight, although appears to have missed Earth. Therefore, the risk of a G1/minor storm on Day 1 (28th Mar) has now diminished.

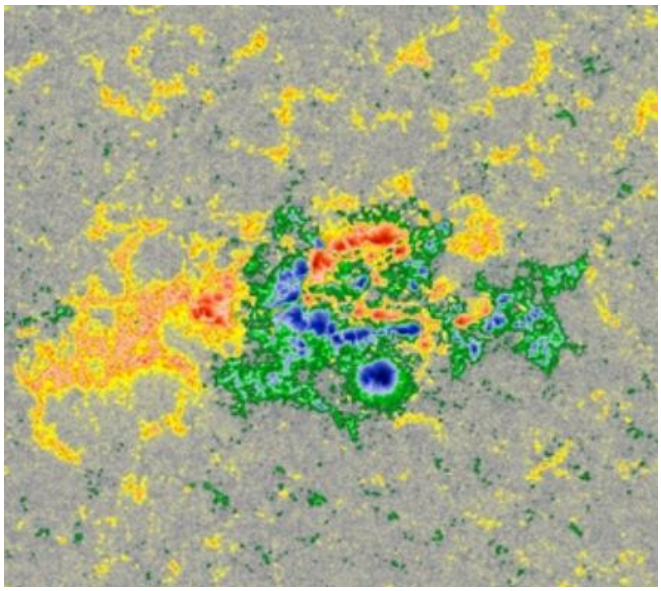
Solar wind speeds are currently elevated, due to the high speed stream from CH69/+. They are expected to remain elevated through Day 1 (28 Mar), slowly easing through Day 2 (29 Mar) as the coronal hole effects wane, which is in-line with observations at STEREO-A. Quiet to Unsettled conditions are expected Day 1 (28 Mar), with a slight chance of isolated Active intervals, due to HSS from CH69/+. Geomagnetic activity is expected to become predominantly Quiet during Day 2 and continue through to Day 4 (31 Mar).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Hmi-magnetogram shows the magnetic complexity of AR2975, with presence of delta spots.



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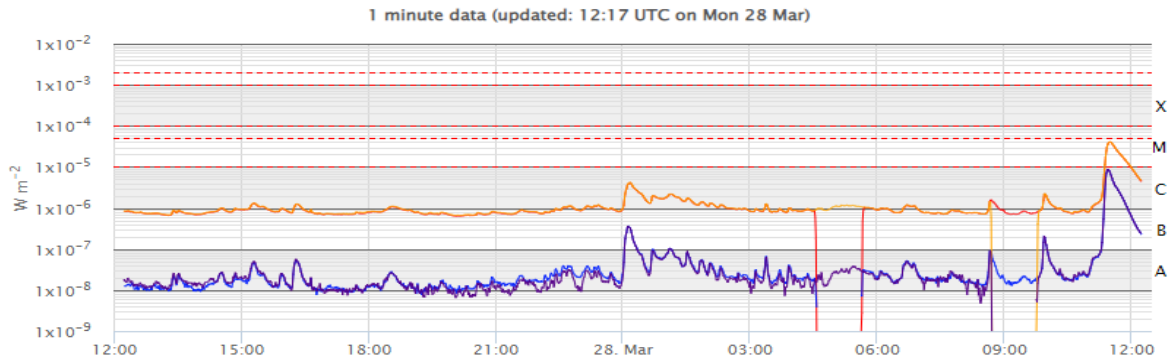
Radio Blackouts - X-Ray Flares:

Solar activity is currently Moderate, with a recent M4 class flare, originating from AR2975 at 28/1128 UTC. AR2975, which is now classified as a Dac/Beta-Gamma-Delta, has developed rapidly recently and has a complex magnetic setup. This region currently shows evident of two delta spots within the group and the magnetic looping and complexity seen in SDO imagery suggests this region as the potential for larger flares to occur, especially if it continues to develop as it rotates into the western hemisphere. AR2978 on the southeast limb has given recent minor C-flares. This region is difficult to classify due to its proximity to the limb, although a trailing sunspot has recently emerged from around the limb, which makes it a larger group, therefore is currently classified as a Eho/Beta configuration. This may further increase the potential for larger flares, although further analyse will be required as it becomes more fully visible. AR2976 is the largest region, which is magnetically complex, with evidence of a delta spot within its leading spot. This has been re-classified as a Eho/Beta-Delta, although no significant flares as yet. AR2977 has developed recently and is currently classified Cro/Beta. AR2974 is a simple Axx/Alpha region. AR2979 in the southeast has shown some growth in its intermediate spots, but appears stable at present. This is currently a Dao/Beta configuration. There is a new and un-numbered sunspot in the southwest, which is a small and simple Axx/Alpha.

Activity is expected to be at least Low, with C-class levels expected. There is a chance activity may increase to Moderate levels, with the main M-flare risk coming from AR2975. Flare probabilities will be re-assessed once AR2978 is fully visible and if AR2975 continues to develop.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16 X-Ray flares – shows the recent M4 class flare originating from AR2975.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES-16 is expected to remain at Background levels. However, there is a slightly raised risk of a radiation storm due to the recent significant development of AR2975, which consists of two delta spots. This increases the probability of a larger flare occurring, which gives the risk of raised proton levels, probably between 5-10% (slight chance) throughout the four day period, especially as AR2975 rotates into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO/AIA 94 images shows the recent M-class flare from AR2975.

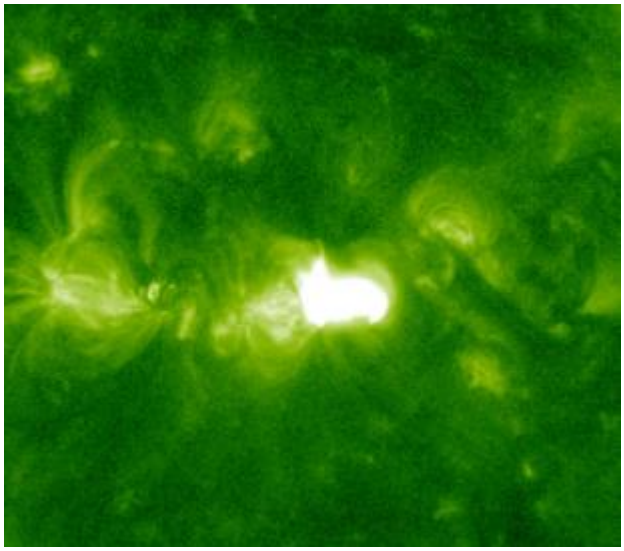
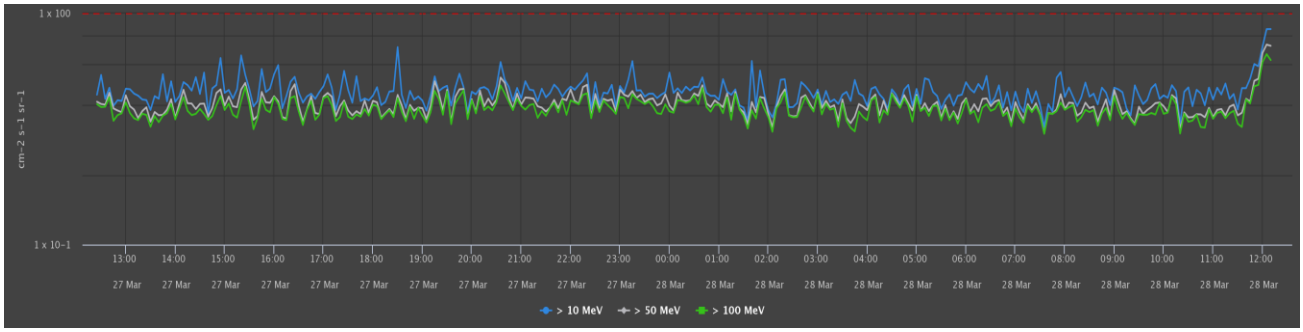


Figure 5: GOES-16 Proton Flux, shows a slight increase due to the recent M-class flare from AR2975, but remains below the Active threshold.



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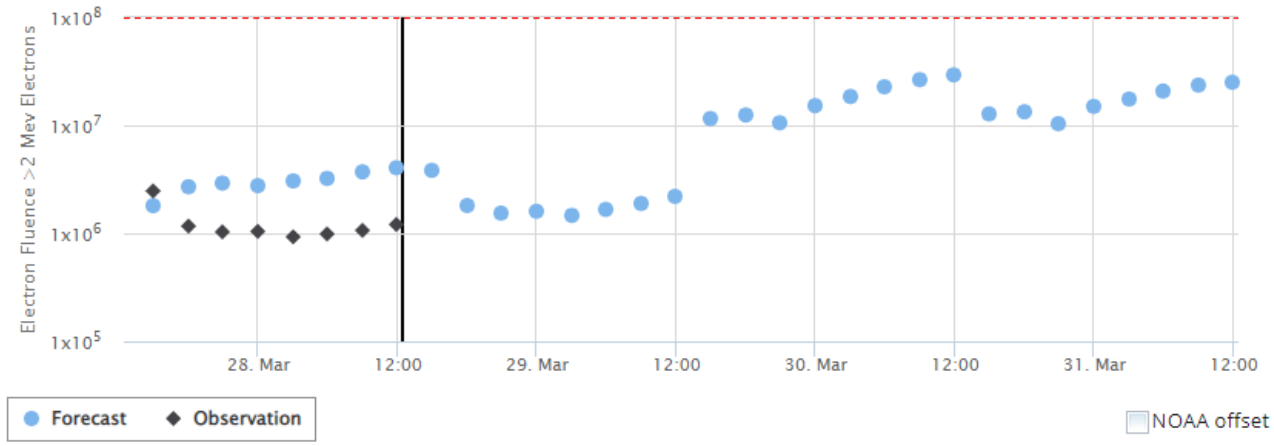
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO is currently at Background levels, but may rise once the high speed stream from CH69 starts to wane. This is further complicated by a possible CME arrival early Day 1 (28 Mar), likely causing flux values to remain suppressed at first. Once this has passed, then a rising trend in electron flux values is possible through the coming days, perhaps reaching High levels at the diurnal peaks by Days 3 and 4 (30-31 Mar). That said, there was little electron response to this feature on the last rotation, although there was a later response to a second HSS. However, this second feature is no longer present on the disc.

The associated 24 hour fluence may follow an erratic rising trend through the next four days, although levels are likely to remain below the Active (1e8 integrated pfu) threshold. REFM is considered to be giving reasonable guidance at the present time, showing a rising trend peaking below Active levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: REFM electron fluence.



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